

# Rare Kaon Decays

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# Historical Perspective

Kaon decays have a parallel history along with the development of the standard model.

Phase	Observation	BR sens	Physics
Early	Long life	1	Strangeness
	Decays of $K^+$ , $K_L$ , $K_S$	0.1	Parity violation
1960s	Semileptonic	$> 10^{-3}$	Meson Dynamics
	Hadronic	$> 10^{-3}$	CP violation
1970-80s	FCNC	$> 10^{-7}$	GIM, Standard Model
1985-present	$\epsilon'/\epsilon$		Direct CP
	radiative decays	$\sim 10^{-8}$	Low Energy QCD
	Forbidden Searches	$\sim 10^{-11}$	Limits on Non-SM
Future	Precision	$\sim 10^{-13}$	SM or New

Progress has been in phases partly driven by accelerator and detector technology. New phase is about to begin.

Focus of this talk:

- $K_L/K_S \rightarrow \pi^0 l^+ l^-$  [ $l = e, \mu$ ]
- $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ ,  $K_L \rightarrow \pi^0 \nu \bar{\nu}$

# Conclusions

- Situation with  $K_L \rightarrow \pi^0 l^+ l^-$  is getting less murky because of the measurements from NA48 of  $K_S \rightarrow \pi^0 l^+ l^-$ .

Is it good enough for a dedicated experiment ?

- Theory of  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  ( $\sim 10^{-10}$ ) and  $K_L \rightarrow \pi^0 \nu \bar{\nu}$  ( $\sim 3 \times 10^{-11}$ ) is very robust.

New understanding of how  $K_L \rightarrow \pi^0 \nu \bar{\nu}$  has sensitivity to new physics. (Bryman, Buras, Isidori, Littenberg, TUM-HEP-583/05)

- JPARC has many LOI for rare decays.  $2 \times 10^{14}$  protons/3.4sec

Pencil beam for  $K_L \rightarrow \pi^0 \nu \bar{\nu}$ .

Stopping beam for  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ .

- $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ : NA48/3.

Perhaps incorporate some CKM features: ring imaging, separated beam.

- $K^+ \pi^0 \nu \bar{\nu}$ : KOPIO waiting for funding.